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ABSTRACT

One concern of science educators is the beliefs of preservice teachers toward science teaching. Consequently, the goal of developing positive beliefs in preservice teachers emerges frequently in science education courses and programs. In science teaching contexts, self-efficacy is an individual's belief that one has the ability to effectively perform science teaching behaviors as well as the belief that his or her students can learn science given factors external to the teacher. This paper reports the results of an investigation into the possible relationship between self self-efficacy beliefs and self-perceptions as a science teacher. (Contains 18 references.) (CCM)

THE RELATIONSHIP OF SCIENCE TEACHING SELF EFFICACY AND OUTCOME EXPECTANCY TO THE DRAW-A-SCIENCE-TEACHER-TEACHING CHECKLIST

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One concern of science educators is the beliefs of preservice science teachers toward science teaching. Consequently, the goal of developing positive beliefs in preservice teachers emerges frequently in science education courses and programs. Studies have indicated that, particularly at the elementary school level, low comfort levels toward science and/or science teaching tend to lead to the sporadic teaching of science, the teaching of science during inadequate blocks of time, or the omission of science instruction from the school day (Finson & Brewer, 1994; Riggs & Enochs, 1990; Wislon & Scharmann, 1994; Koballa & Crawley, 1985).

In science teaching contexts, self-efficacy is an individual's belief that one has the ability to effectively perform science teaching behaviors (called personal science teaching efficacy) as well as one's belief that his/her students can learn science given factors external to the teacher (called science teaching outcome expectancy) (Ramey-Gassert, Shroyer & Staver, 1996).

When teachers have low self-efficacy, their teaching tends to be characterized by authoritative, teacher-centered roles with a less clear understanding of the various developmental levels of their students. Rubeck and Enochs (1990) reported that teachers who were weak in content background tended to have significantly lower personal efficacy than did teachers with strong content backgrounds. In contrast, teachers with high self-efficacy tended to teach in way

characterized by the use of inquiry approaches, more student-centered thought, beliefs that they can help any student overcome learning problems and succeed, and were more knowledgeable of their students' developmental levels. One logical conclusion is that the way preservice teachers view themselves and their roles in a science teaching context is at least partially derived from their self-efficacy.

The attitudes students possess with respect to science may also be related to the ways they perceive themselves in the role of being a scientist. Yager and Yager (1985), for example, found that if the work in which scientists engage is viewed as being unpleasant, then one's perception of a scientist (or the prospect of becoming a scientist) becomes more negative. Investigations into the perceptions of scientists have occurred for decades, with a notable early study being Mead and Metraux's work in 1957. Their work led later researchers to examine elements of students'

perceptions which could be classified as stereotypical (Chambers, 1983; Schibeci & Sorensen, 1993; Ward, 1977). The elements of one's perceptions about scientists are revealed through drawings one makes of a scientist. These stereotypical elements were refined by Chambers (1983) in his Draw-A-Scientist Test and later organized into a quantifiable checklist (the DAST-C) format by Finson, Beaver and Cramond (1995).

Thomas and Pederson (1998) reasoned that since students' drawings reveal much about their perceptions of scientists, drawings might also reveal students' perceptions about themselves as science teachers. In their work, Thomas and Pederson began with the DAST-C and revised it to include elements they judged to be characteristic of science classrooms and science

teachers, calling the instrument the Draw a Science Teacher Teaching Checklist (DASTT-C). Through a collaborative effort with over a dozen science educators, the DASTT-C was further revised and refined.

This presentation will report the results of an investigation into the possible relationship between one's self-efficacy beliefs and perceptions of self as a science teacher.

Methodology

Sample

One hundred thirty-five preservice elementary teachers were utilized in this study. Students were enrolled within science methods courses at either a Midwestern or southern California university.

Instrumentation

During the first course period, students completed two instruments–the Science Teaching Efficacy Belief Instrument, STEBI-B (Enochs & Riggs, 1990) and the Draw-A-Science-Teacher-Teaching Checklist.

Within this study, reliability for the 13 item self-efficacy subscale of the STEBI-A was 0.89. This scale measures preservice teachers' beliefs in their ability to teach science. The alpha for the 10 item outcome expectancy scale was 0.78. This scale measures preservice elementary teachers' belief in that students can learn, given effective teaching. Both scales are based upon the social learning theory of Albert Bandura (1982) and the measurement work of Gibson and Dembo (1984).

The Draw-A-Science-Teacher-Teaching Checklist (DASTT-C) is a newly developed

instrument. Its format and implementation is reported here. The DASTT-C utilized within this study is based upon the work of Thomas and Pederson (1998). This version consists of two-pages. The first page is for subjects to make their drawings and includes a square in which the drawing is to be made. Other information at the top of this page solicits demographic information, such as whether the subject is an elementary or secondary teacher, gender, and so forth. The second page is the checklist itself. The checklist is divided into four sections: teacher, students, environment, and relevant captions/non-prompted comments/other.

The teacher and student sections are subdivided into items dealing with "activity," "position," and "attitude/expression." The teacher activity subsection lists types of activities or actions the teacher might be typically performing in the science classroom (lecturing, using visual aids, etc.). The position subsection notes the teacher's location in the classroom and his/her posture. The attitude/expression subsection notes whether or not the teacher is happy or smiling. The student subsection on activity lists types of student activities typically present in the classroom, such as watching and listening and doing seat work. The student subsection on position notes whether or not students are arranged in rows, and the attitude subsection notes whether students appear to be smiling (happy). An additional part to the student section is for the gender of students to be noted.

The "environment" section of the checklist lists circumstances under which science instruction occurs, such as whether the instruction is indoors; how the teacher's and students' desks are arranged; the presence of laboratory materials/equipment on desks and tables; symbols of science, math, technology, etc.

The last section of the checklist allows the user to make note of any relevant captions which are present on drawings, including formulae, labels, explanations or descriptions subjects included with their drawings, and user comments.

Each of the first three subsections can be scored separately, and the subtotals are added to derive an overall DASTT-C score. The range of possible scores for the teacher subsection is 0-9, that for the students' subsection is 0-5, and that for the environment subsection is 0-9. The total range of possible scores for the checklist is thus 0-23.

A subgroup of ten student drawings, randomly selected, was used to determine inter-rater reliability for the DASTT-C in this study. The three authors separately scored the drawings and report the reliability to be $r = 0.733$.

Analysis

The following variables were selected from the DASTT-C and checked for individual correlation with the two subscales of the STEBI-B:

- Teacher demonstrating/handling/manipulating objects,
- Students conducting hands-on activity,
- Environment inside, and
- Environment includes symbols of science.

Additionally, a qualitative analysis of five to seven subjects' drawings was completed for each of high and low self-efficacy and outcome expectancy areas. Selections were made from those subjects who scored two or more standard deviations above or below the STEBI-B subscale means. The four subgroups' drawings were reviewed for patterns related to included or

excluded variables.

Results

Table 1 reports the descriptive statistics for the two subscales of the STEBI-B. Table 2 depicts Pearson Correlations for each of the four selected dichotomous DASTT-C variables and the self-efficacy and outcome expectancy subscales. Self-efficacy was significantly and negatively correlated with an inside environment ($p = .027$). Outcome expectancy correlated with the three variables teacher demonstrating or handling objects, students conducting hands on activities, and an environment including symbols of science.

Table 1
Descriptive Statistics

	N	Min. Score	Max. Score	Mean	Std. Dev.	Reliability
Self Efficacy (13 Items)	148	13	65	47.95	7.31	.89
Outcome Expectancy (10 Items)	135	10	50	35.51	5.03	.78

Qualitative review of the high and low efficacy and outcome expectancy pictures revealed the following trends in the four categories:

High Self Efficacy

All five of the high efficacy teachers included captions within their drawings. Four out of the five included captions which specifically outlined teacher and student actions which portrayed experimentation and/or activity with objects.

Table 2
Correlations Table

	S. Conduct	Inside Env.	Sym. Of Science	Self Efficacy	Outcome Expectancy
T. Demonst.	0.084	-0.061	0.318	-0.004	0.152
S. Conduct.		-0.005	0.222	-0.008	0.201
Inside Env.			0.125	-0.166	0.058
Sym. Of Sci.				0.094	0.134
Self Efficacy					0.181

$N = 135$

Low Self-Efficacy

All low efficacy drawings but one included questioning looks and/or comments from the teacher and/or students. Only one of these drawings included a group arrangement. Four of the five depicted the teacher as the central figure with students either absent or watching.

High Outcome Expectancy

No obvious patterns were evident within the drawings of high outcome expectancy people.

Low Outcome Expectancy

Six out of the nine drawings of the lowest outcome efficacy subjects did not picture students.

Discussion

The relationship of self-efficacy to drawings which were not picturing an inside classroom seems appropriate. One might expect those who have higher self efficacy to be willing to use the outdoors as a setting for their students' science learning.

It was interesting to note that those highest in self-efficacy were very likely to include captions which explained the teacher and student behavior. This supports the theory's notion that

those with self-efficacy believe in their own ability to teach. While not prompted to include captions, these teachers were willing to add an explanation which focused on the steps of their pictured lessons. Contrarily, low efficacy teachers were more likely to include the expected questioning looks or comments from themselves or their students. Additionally, these teachers typically did not picture groups and they illustrated themselves as the central figure. This is consistent with past research which suggests that teachers low in self-efficacy are less likely to utilize groups.

Outcome expectancy's relationship to teachers' and students' use of materials supports the notion that those who believe that student learning is possible might also be more likely to utilize teaching strategies which allow students more variability in their classroom behavior. In other words, these teachers might be more apt to relinquish some of their own control of the classroom since they trust that students can learn.

When one considers the inclusion of symbols of science as also related to outcome expectancy, an additional proposition might be offered. Perhaps teachers highest in outcome

expectancy are more likely to put great effort into their teaching which would result in drawings with more elaborate activity-based drawings with pictured symbols of science to support student learning. If a teacher believes that students are more likely to learn given effective teaching, they might be more likely to define teaching as going beyond a minimalist approach to teaching which might simply picture a teacher at the head of a class.

An interesting finding of the qualitative review of the drawings is that those low in outcome expectancy tended to not include students. This tendency supports the definition of outcome expectancy in that those who do not harbor this belief might dismiss the role that students play within the learning process. Teachers with such beliefs might perceive the science classroom as a teacher conducting a lesson with little recognition of the role that students play within the learning process.

Conclusions

While this study reveals a limited amount of support and explanation for the theory of self-efficacy and outcome expectancy, further development of the DASTT-C will better enable researchers to investigate the relationship of pictured classroom factors to science teaching self-efficacy and outcome expectancy. Additionally, this measure could prove to be a helpful assessment of preservice science teachers.

Specifically, the DASTT-C might better define its purpose and meaning. For example, should one utilize the DASTT-C as a pre/post assessment of the students' in a science methods course, what would the total of subscores indicate? Does a higher score truly indicate that there has been a change in students' perceptions over the course of the methods class?

Additionally, in utilization of the DASTT-C, these researchers found that some variables were difficult to score and not easily distinguishable from others. For example, almost all pictured teachers appeared to be leading and in charge. It was difficult to determine if teachers were lecturing, discussing, or giving directions except when the artists had included captions which noted what the teacher and/or students were saying and/or doing.

Investigation of preservice teachers' self-portraits is of value to, at the very least, science teacher educators and their students. With further refinement, the DASTT-C can increase its value to research in the field of science teacher education.

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